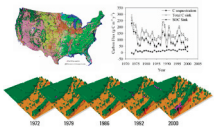
USGS
science for a changing world

Climate Change Research at USGS Center for Earth Resources Observation and Science (EROS)

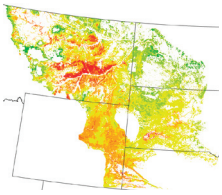
Research and development projects at EROS apply unique resources to support the USGS mission of developing understanding, monitoring, and modeling of climate variability and change and their human, physical, and biological impacts. Remote sensing resources, both new and archived, form the core of our ability to determine changes in the state or condition of the Earth's surface and its dynamic landscape and ecosystem processes. This rich resource provides powerful biophysical information for local to global areas. Archival data form the basis for assessing human and climate impacts on the land surface, trends of land use, and an understanding of climate and management impacts. Biophysical information from satellite data is assimilated into quantitative models that allow all disciplines of the USGS to understand impacts on ecosystem processes. Major processes and problems we address include: carbon fluxes, hydrological processes, albedo changes and regional climates, mangroves and wetland protection of coastal environments, natural and manmade hazards (e.g., fire and drought), ecosystem change and succession, land use and land cover change, and more. The integration of remote sensing, modeling, and multidisciplinary approaches fosters international scientific leadership across all disciplines for the USGS.

Global Carbon Cycle



Carbon Status and Trends

We contribute to quantifying the status and trends of carbon stocks in vegetation and soils and to the assessment of the effects of land management actions and climate change on the carbon cycle. Our goal is to understand and quantify the magnitude, mechanisms, spatial distribution, and temporal changes of carbon stocks, sources, and sinks in the conterminous United States.



Regional Carbon Extrapolation in the Northern Great Plains

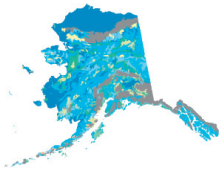
We estimate net ecosystem exchange and gross primary production in the Northern Great Plains. Carbon sink and source areas in grasslands are identified using remotely sensed data as an input to a piecewise regression model. The quantitative estimates of net ecosystem exchange across the landscape will provide validation for total system biogeochemical modeling, and allow climate change scenarios to be simulated.

Carbon Fluxes and Climate Change in the Great Plains

In cooperation with South Dakota State University, we evaluate the net exchange of carbon at many sites including the AmeriFlux and AgriFlux networks. We create models of carbon fluxes, and simulate those fluxes at high resolution across the Great Plains.

Carbon Status and Potential on Federal Lands

The Federal government has direct responsibility for about 29 percent of the nation's land. Carbon stocks on those lands vary in intensity from high in the north to low in arid areas. Our goal is to understand and quantify the magnitude, mechanisms, spatial distributions, and temporal changes of carbon stocks, sources, and sinks on lands of the Department of the Interior in support of land management and policy decisions.



Soil Landscape Modeling in Alaska

We use site-specific soil profile data as input to biogeochemical models. A soil landscape model is being developed that integrates existing topographic, soil, vegetation, and solar insolation data to stratify the landscape for carbon stock and flux modeling. Carbon flux modeling is summarized into carbon budgets for the Yukon River Basin in support of the International Polar Year.

U.S. Department of the Interior
U.S. Geological Survey

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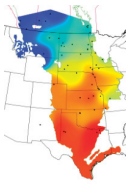
Land Use and Land Cover change



Stable Isotope Distributions and Paleoclimate Reconstructions in the Great Plains

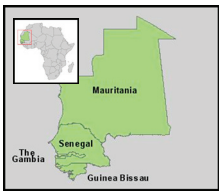
Carbon isotopic analyses of soil carbon in native grasslands and analyses of biodiversity are combined to provide the first comprehensive paleotemperature record in the Great Plains of North America. This dataset is being used to reconstruct Great Plains climate anomalies, show links to sea surface temperatures, and project the future effects of climate change on ecosystem performance, species distributions, and carbon sequestration.

Sahel Land Use and Land Cover Trends

We are monitoring national and regional land use and land cover changes from the 1970s to the present. We integrate multi-temporal and multi-sensor imagery to provide an improved understanding of human and climate drivers of rapid landscape changes, build land analysis capacity in the region, and identify land degradation and improvement.

Human Impacts on Land Performance in the Sahel

We are identifying and quantifying changes in land productivity across many countries in the Sahel. We document major successes in land management by local communities that have led to improved vegetation, soil, and agricultural conditions. We integrate measured increases in biomass and soil carbon stocks with biophysical modeling to assess the potential for increasing land productivity and carbon sequestration over large regions.

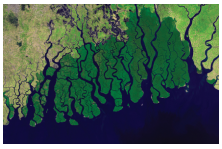


Sequestration of Carbon in Soil and Biomass in the Sahel

We are evaluating the effects of land management strategies and climate change in West Africa's vulnerable Sahel region. We use remote sensing and geospatial data to quantify changes in land cover – both the conversion of land cover and its modification by humans and climate. Both have contributed to large losses of carbon. We integrate socioeconomic and biophysical assessments to model current and future scenarios to develop information for policy decisions.

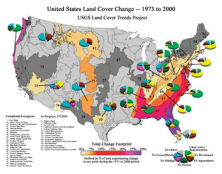
Biodiversity Characterization

We are mapping biodiversity distribution, monitoring changes in land cover, and studying the effects of climate change on biodiversity and land cover. We have created new land cover datasets of North America (1 km) and Greater Mesoamerica (500 m), prepared data on the species distribution of mammals, birds, and reptiles, and identified priority conservation areas of Greater Mesoamerica.



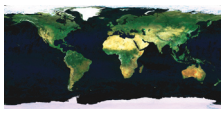
Mangrove Forest Dynamics

We are studying the dynamics of mangrove forests using historical Landsat imagery to understand the role of mangrove forests in saving lives and protecting property from natural disasters such as tsunamis. The rates and causes of mangrove deforestation are identified for the period 1975-2005.



Land Cover Trends

In the Land Cover Trends Project, we are documenting the types, rates, causes, and consequences of land cover change from 1973 to 2000 within each of the 84 U.S. Environmental Protection Agency (EPA) Level III ecoregions that span the conterminous United States. This study is the first comprehensive land cover change analysis ever conducted. Results from this research will contribute to a national assessment of land cover change.



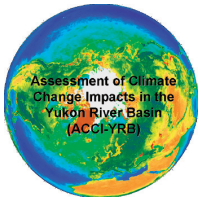
Global/Regional Land Cover Monitoring

The North American Land Change Monitoring System monitors land cover changes occurring at multiple scales on an annual basis. The project is implemented by USGS, the National Institute of Geographic Statistics and Information of Mexico (INEGI) and the Canada Centre for Remote Sensing (CCRS). USGS EROS also supports the implementation of the ongoing GLOBCOVER project of the European Space Agency (ESA) to produce a global land cover database for the year 2005 using Medium Resolution Imaging Spectrometer (MERIS) data.

IABIN-DGF Geointegrator

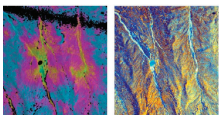
USGS EROS and the World Bank support the implementation of online GIS systems that help decision makers and the public obtain data and visualize the impacts of climate change in MesoAmerica and the Caribbean. The Geointegrator project conducts research on biodiversity and supports the InterAmerican Biodiversity Information Network (IABIN) that links 10 national ministries of the environment and 14 other institutions.

Climate Variability and Change



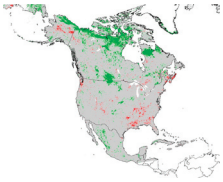
Climate Change in the Yukon River Basin

Understanding the carbon cycle in high northern latitudes is critical because climate warming leads to thawing soils and changing ecosystems. Changes in the carbon cycle could create strong positive feedbacks involving the release of greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4), potentially accelerating global warming. We collaborate with many scientists to conduct research on the underlying processes of the carbon cycle, create models of whole systems, and make increasingly reliable estimates of carbon fluxes between the land and atmosphere.



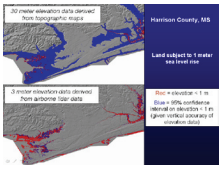
Satellite Radar for Measuring Permafrost Subsidence

Using data from the Japanese Earth Resources Satellite-1 (JERS-1) in an interferometric synthetic aperture radar (InSAR) analysis, we quantified about 10 centimeters of subsidence near Toolik Lake, Alaska. We are collaborating with the Canada Centre for Remote Sensing to map changes associated with permafrost degradation in Arctic Alaska and Canada, with an emphasis on the Yukon River Basin and Herschel Island. We will use Radarsat 2 and Advanced Land Observing Satellite (ALOS) data in addition to JERS-1.



National Phenology Network

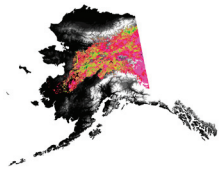
Phenology is the study of the timing of recurring biological events (such as the timing and length of the growing season) and their response to environmental changes, especially weather and climate. Time-series analysis of satellite imagery provides an objective method of monitoring changes in seasonal characteristics of the land surface. The new National Phenology Network will provide a means of connecting the satellite data to ground-based observations and will be a way to communicate some of the impacts of environmental change to the public.



Identification of lands vulnerable to sea level rise

In this project, we used high resolution lidar to develop maps of coastal lands subject to sea level rise. The spatial detail and accuracy of elevations derived from lidar data lead to better identification of vulnerable areas than was possible previously. The improved maps include a spatial representation of the uncertainty of the delineations, based on knowledge of the vertical accuracy of the elevation data. A Web-based map and data server is being developed on which maps, GIS data, and project reports can be viewed and downloaded.

Ecosystems

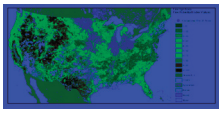


Ecosystem Performance in the Yukon River Basin

We are developing a model of expected ecosystem performance in the boreal forests of the Yukon River Basin of Alaska and Canada. We identify trends in areas that are under-performing (lower productivity than expected) and over-performing (higher productivity than expected), based on an analysis of remotely sensed images, climate data, and estimated site potential. Collaborating with Canadian remote sensing scientists, we will do a seamless analysis for the Yukon River Basin at 1-kilometer resolution from 1985 and at 250-meter resolution from 2000 to the present.

Ecosystem Services

The Integrated Landscape Monitoring Prairie Pilot is one of four pilot projects developing and implementing remote sensing and modeling approaches to understand, quantify, and map ecosystem services. Our goal is to develop a regional monitoring framework that can be used to model and estimate the performance of ecological processes in the delivery of specific goods and services at multiple scales under various management, policy, and climate change scenarios.



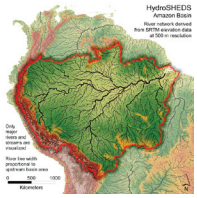
Fire Potential Forecasting

The climate affects the frequency and severity of wildfire occurrence. To understand and mitigate these effects, it is necessary to monitor and forecast fire potential. Fire potential forecasts are derived by combining daily weather and vegetation condition information. The combination of vegetation condition and weather information identifies the moisture condition of the live and dead vegetation. Fire potential forecasts enable local and regional fire planners to measure fire ignition risk.

National Ecological Observatory Network (NEON)

The National Ecological Observatory Network (NEON) will be the first national ecological measurement and observation system designed to meet the nation's grand ecological challenges. We are collaborating with the National Science Foundation and NEON, Inc., on geographic analyses for instrument site selection, a package of land characterization information for the sites, and airborne and satellite data acquisition and analyses.

Global Water Cycle



HydroSHEDS

The USGS has been cooperating with the World Wildlife Fund (WWF) and other organizations to create the HydroSHEDS (Hydrological data and maps based on SHuttle Elevation Derivatives at multiple Scales) data set (http://hydrosheds.cr.usgs.gov). This global hydrologic derivatives data set is based on 3-arc-second SRTM elevation data. HydroSHEDS represents a 100-fold increase in resolution over USGS HYDRO1k. We have completed South America, Central America, and Asia and our goal is to have the rest of the world done by the end of calendar year 2007.

FEWS NET

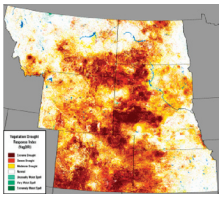
Famine Early Warning Systems Network (FEWS NET)

The FEWS NET activity at EROS, in partnership with the Geography Department of the University of California, Santa Barbara, is addressing the long term implications of climate change for food security in sub-Saharan Africa using modeling results from the Intergovernmental Panel on Climate Change 4th Assessment Report. The simulations (an ensemble of 132 simulations of global climate by 11 different models for 1950 to 2100) describe dramatic and coherent increases in precipitation over the tropical Indian and Pacific Oceans. Theory, observation, and modeling link these increases in oceanic precipitation to decreases in rainfall over food-insecure regions of western, eastern, and southern Africa. Implications of these results are used to orient long term planning by food aid and development decision makers at the U.S. Agency for International Development in Africa and Washington, D.C.

NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

The National Integrated Drought Information System (NIDIS)

USGS/EROS is participating in the establishment of NIDIS, the new drought early warning system for the U.S. NIDIS will integrate and deliver physical/hydrological observations and socioeconomic impacts data through a web portal and extensive human/institutional networks. EROS is especially well-positioned to assist in the area of geographic analysis and monitoring, and development of land remote sensing applications. EROS is also contributing to the leadership of NIDIS through assignment of a scientist to serve as Deputy Director of the NIDIS Program Office at NOAA's Earth System Research Laboratory. Important linkages to climate variability and change activities of the USGS global change program are being made, to increase engagement with the broader climate change impacts community.



Drought Monitoring

Droughts are part of natural climate variability. Because droughts have large spatial and temporal variability, are slow to emerge, and vary in their characteristics by location and sector, they are challenging to map and monitor with a high level of spatial detail. We have used satellite image data to develop an experimental index, the Vegetation Drought Response Index (VegDRI), to provide decision-makers with sub-county-scale drought severity information. VegDRI helps authors of the weekly U.S. Drought Monitor fill in gaps between stations of national instrument networks, and provides insight to county-level impacts assessment.